Appendix D

Procedures Used in Model Comparisons

Similar to the Agency for Toxic Substances and Disease Registry (ATSDR) Health Consultation (ATSDR 2000), data from the Field Sampling Plan Addendum (FSPA06) conducted in support of the remedial investigation (RI) (URS Greiner and CH2M Hill 2001) were used in this analysis. For the present study, however, the number of homes was slightly different for two reasons: (1) data for two houses originally tabulated in the RI were not used in the ATSDR comparison—these were added for the committee comparisons. (2) The ATSDR analysis used geometric mean house-dust values for seven houses where those data were not originally collected. In the present comparison, those houses were dropped from consideration, and the results are based solely on residences where both soil and house dust measurements were available. The data set used in these calculations (referred to below as the 75 homes' data) is presented in Table D-1 of this appendix.

THE ONTARIO MINISTRY OF ENVIRONMENT AND ENERGY BIOKINETIC SLOPE FACTOR MODEL

The Ontario Ministry of Environment and Energy (OMOEE) has established an intake of 3.7 micrograms (μg) lead per kilograms (kg) of body weight/day as the level of intake for which more than 95% of children will have blood lead values less than 10 μg per deciliter (dL). This intake of concern (IOC) is divided by 2 to provide a safety factor; the resulting IOC is 1.85 μg of lead/kg of body weight/day. For the model comparisons, lead

TABLE D-1 FSPA06 Data Used in Calculations

House	Arithmetic Mean of Yard Soil, 0-1 in. (mg/kg)	Geometric Mean of Community Soil (mg/kg)	Vacuum Bag Dust	House	Arithmetic Mean of Yard Soil, 0-1 in. (mg/kg)	Geometric Mean of Community Soil (mg/kg)	Vacuum Bag Dust
1	663	419	606	38	278	419	427
2	804	419	480	39	1,423	568	1,020
3	174	419	764	40	364	352	341
4	448	419	173	41	766	628	682
5	4,796	110	3,140	42	769	419	23
6	1,189	419	1,000	43	688	368	1,820
7	1,610	628	1,620	44	16,026	771	6,150
8	1,080	419	978	45	718	568	2,430
9	870	419	528	46	503	419	769
10	259	419	390	47	500	568	387
11	623	257	525	48	3,054	568	2,730
12	239	257	422	49	843	568	619
13	979	419	154	50	852	771	3,300
14	290	257	389	51	56	368	626
15	665	257	765	52	319	419	504
16	342	419	332	53	256	419	492
17	760	419	1,260	54	3,026	419	621

18	3,491	352	604	55	787	419	1,550
19	5,566	628	1,960	56	735	257	315
20	794	419	1,200	57	544	368	504
21	1,014	568	1,660	58	642	568	384
22	276	352	680	59	353	368	833
23	796	419	818	60	2,711	568	353
24	871	419	512	61	1,165	771	778
25	451	771	639	62	188	257	232
26	1,337	771	1,350	63	284	568	1,680
27	1,687	771	798	64	563	419	655
28	977	419	808	65	2,701	628	1,540
29	813	568	703	66	1,194	352	937
30	438	568	84	67	1,094	771	780
31	682	419	762	68	2,788	568	1,380
32	622	568	349	69	479	568	727
33	1,322	628	767	70	1,381	568	405
34	437	568	383	71	321	771	942
35	1,576	568	1,020	72	3,837	419	362
36	827	628	710	73	2,861	628	2,840
37	3,603	568	1,020	74	694	368	2,400
				75	807	419	1,000

SOURCE: Data provided by Idaho Department of Health and Welfare, unpublished material, 2004.

intake from soils, dusts, water, air, and food is calculated from measured media concentrations and added to background default levels in non-measured media. The factor by which the estimated intake exceeds the IOC is obtained by dividing the result by 1.85 μg lead/kg body weight/day. The percentage of locations for which exposure estimates are less than a factor of 2 above the IOC is taken as the percentage of children whose blood lead values are less than 10 μg/dL.

BATCH OPERATION OF THE INTEGRATED EXPOSURE UPTAKE BIOKINETIC MODEL

The 75 homes' data were used for blood lead estimates using the batch mode capability of the integrated exposure uptake biokinetic (IEUBK) model. For these comparisons, the estimated blood lead level at an age of 20 months was obtained. This age matches closely the age corresponding to maximum blood lead concentration and also corresponds approximately to the 16 kg body weight for which the OMOEE IOC computation is made.

IMPLEMENTATION OF THE O'FLAHERTY MODEL

The physiologically based, transport limited biokinetic model of O'Flaherty (O'Flaherty 1998) was applied to the 75 homes' data for comparison with the other models. Such comparisons are not exact because of differences in how the models specify input of exposure regimes and the way bioavailability is incorporated in the computations. Another impediment is the sensitivity of the O'Flaherty model to year of birth for the individual being simulated. As noted in the TRW adult lead model review (EPA 2001, Appendix K), a variety of model parameters may be adjusted in the exposure specifications to establish baseline conditions against which variations in soil and dust lead concentrations may be examined. For the O'Flaherty model implementation here (Advanced Continuous Simulation Language [ACSL] platform) the following variable values were used for model runs: year of birth, yob = 1980; frlung = 0.32 (bioavailability of inhaled lead—same as IEUBK); cair2 = 0.1 $\mu g/m^3$ (same as IEUBK); concentration of lead in water, cwater = 4 μg/L (same as IEUBK); rfood2 = 20 μg of lead/day ingested by adult; rfood3 = 15 μg lead/day ingested by child; and the concentration of lead in infant formula, cfmla = 0.01 μg/L. For tabulation in Table 6-3, the midpoint between blood lead at ages 12 and 24 months was used.

ADAPTATION OF MODELS FOR PREDICTIONS UNDER THE BUNKER HILL SUPERFUND SITE "BOX MODEL" CONDITIONS

The study of von Lindern et al. (2003) established a set of IEUBK model conditions that best fit the observed blood lead distribution for

children living within the Bunker Hill Superfund site (BHSS). Discussion of this model and an evaluation of its application to predictions of blood lead levels for children living in the Coeur d'Alene River basin outside the BHSS box is detailed in the body of the report. Important points for the present comparison of model results are as follows: (1) the soil and dust exposure regime was weighted as 40% from household dusts, 30% from the residential soil, and 30% derived from the community-wide soils; and (2) bioavailability for soil and dust ingestion was set at 18%.

Soil lead values for the 75 homes' data (BHSS box conditions) were tabulated on a geographical location basis as the average between the individual residential lot surface-soil value and the geometric mean soil value for the community where the residence was located. The latter values were derived from the human health risk assessment for operable unit 3 (TerraGraphics et al. 2001, Table 6-48). To account for the lower bioavailability of lead in soils and dusts used in the box model, concentration values for these inputs were reduced to 60% of their original values before each model's invocation. This corresponds approximately to the change in bioavailability used in the box model version of the IEUBK model, since the default bioavailability from soil in the IEUBK is 30%. This approach was adopted because bioavailability, the fraction of lead intake that is taken up in the blood, could not be adjusted in the ATSDR model. The modification of the soil concentration achieves the same effect, because the model exhibits a linear response over the concentration ranges of interest. In the O'Flaherty model, the user cannot specify bioavailability, but the ACSL program constants were adjusted to reflect 40% dust and 60% soil inputs to the exposure module of the program. The O'Flaherty model uses age-specific soil/dust-ingestion rate functions that are not accessible in the executable program structure but whose average value is about 60% of the average IEUBK default ingestion regime.

REFERENCES

ATSDR (Agency for Toxic Substances and Disease Registry). 2000. Health Consultation. Coeur d'Alene River Basin Panhandle Region of Idaho Including Benewah, Kootenai and Shoshone Counties. Office of Regional Operations, Region 10, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, Department of Health and Human Services [online]. Available: http://www.atsdr.cdc.gov/HAC/PHA/basinres/bas_toc.html [accessed Jan. 4, 2005].

EPA (U.S. Environmental Protection Agency). 2001. Review of Adult Lead Models: Evaluation of Models for Assessing Human Health Risks Associated with Lead Exposures at Non-Residential Areas of Superfund and Other Hazardous Waste Sites. OSWER #9285.7-46. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC. August 2001 [online]. Available: http://www.epa.gov/superfund/programs/lead/products/adultreview.pdf [accessed Jan. 3, 2005].

O'Flaherty, E.J. 1998. A physiologically based kinetic model for lead in children and adults. Environ. Health Perspect. 106(Suppl. 6):1495-1503.

TerraGraphics/URS Greiner/CH2M Hill. 2001. Final Human Health Risk Assessment for the Coeur d'Alene Basin Extending from Harrison to Mullan on the Coeur d'Alene River and Tributaries, Remedial Investigation/Feasibility Study. Prepared for Idaho Department of Health and Welfare, Division of Health, Idaho Department of Environmental Quality, U.S. Environmental Protection Agency Region X, Seattle, WA, by TerraGraphics Environmental Engineering, Inc, URS Greiner in association with CH2M Hill [online]. Available: http://www.epa.gov/r10earth/offices/sf/BH_HHRA_final/TableOfContents.pdf [accessed Jan. 3, 2005].

URS Greiner, Inc., and CH2M Hill. 2001. Final (Revision 2) Remedial Investigation Report, Remedial Investigation Report for the Coeur d'Alene Basin Remedial Investigation/Feasibility Study. URSG DCN 4162500.6659.05a. Prepared for U.S. Environmental Protection Agency, Region 10, Seattle, WA, by URS Greiner, Inc., Seattle, WA, and CH2M Hill, Bellevue, WA. September 2001.

von Lindern, I.H., S.M. Spalinger, V. Petroysan, and M. von Braun. 2003. Assessing remedial effectiveness through the blood lead: Soil/dust relationship at the Bunker Hill Superfund Site in the Silver Valley of Idaho. Sci. Total Environ. 303(1-2):139-170.